AMENDMENT

Amendment to Claims

Please amend the numbering of the claims as follows

[10] 8.(Amended) A method of processing memory requests, the method comprising:

receiving a request for a memory operation;

determining if data for the memory operation already exists in a cache memory;

performing a cache memory operation, if the data already exists in the cache;

if the data does not already exist in the cache:

accessing a hard disk that contains the data for the memory request;

performing a disk memory operation; and

performing any queued up disk memory operations.

[11] 9.(Amended) The method of claim [10] 8, wherein the memory operation is a read operation.

[12] 10.(Amended) The method of claim [10] 8, wherein accessing a hard disk further comprises spinning up the hard disk.

[13] 11.(Amended) The method of claim [12] 10, the method further comprising spinning down the hard disk after performing any queued up disk memory operations.

[14] 12.(Amended) The method of claim [10] 8, wherein if the data does not already exist in the cache, the method further comprising:

determining if the request is part of a sequential stream;

if request is part of a sequential stream, deallocating cache lines in the cache memory and prefetching new cache lines;

if request is not part of a sequential stream, determine if prefetch is desirable; and

if prefetch is desirable, prefetch data.

[15] 13. (Amended) The method of claim [14] 12, wherein the prefetch is queued up as a disk memory operation.

[16] 14. (Amended) The method of claim [10] 8, wherein performing any queued up disk memory operations further comprises determining if the queued up disk memory operations are desirable and then performing the queued up disk memory operations that are desirable.

[17] 15. (Amended) The method of claim [10] 8, wherein the memory operation is a write operation.

[18] 16. (Amended) The method of claim [10] 8, wherein the cache operation further comprises writing data into the cache.

[19] 17. (Amended) The method of claim [18] 16, wherein the cache operation further comprises queuing up a disk memory operation, wherein the disk memory operation will transfer the data to the disk.

[20] 18. (Amended) The method of claim [19] 17, wherein the queued up disk memory operations are periodically reviewed to ensure their continued desirability.

[21] 19. (Amended) The method of claim [10] 8, wherein the disk memory operation further comprises writing data to the disk.

[22] 20. (Amended) The method of claim [10] 8, wherein the queued up memory operations include writing data from the cache to the disk.

[30] 21. (Amended) A method of performing a read memory operation, the method comprising:

receiving a read request;

determining if data to satisfy the read request is located in the cache;

satisfying the read request from data in the cache, if the data is located in the cache;

if the data is not located in the cache, performing a disk read operation, wherein the disk read operation comprises:

accessing the disk;

allocating a new cache line;

transferring data from the disk to the new cache line; and

satisfying the request.

[31] 22. (Amended) The method of claim [30] 21, wherein accessing the disk further comprises spinning up a hard disk.

[32] 23. (Amended) The method of claim [31] 22, wherein the method further comprises spinning down the hard disk after satisfying the request.

[33] 24. (Amended) The method of claim [30] 21, wherein the disk read operation further comprises:

determining if the data transferred from the disk to the new cache line is part of a sequential stream;

if the data is part of a sequential stream, prefetching new cache lines;

if the data is not part of a sequential stream, determining if prefetch is desirable; and

if prefetching is desirable, performing a prefetch.

[34] 25. (Amended) The method of claim [30] 21, wherein prefetching further comprises queuing up a prefetch operation to be executed during a next disk memory operation.

[40] 26. (Amended) A method of performing a write memory request, the method comprising:

receiving a write request;

determining if at least one line in the cache is associated with the write request;

if at least one line in the cache is associated with the write request, performing a cache write to the line; and

if no lines in the cache are associated with the write request, performing a new write operation.

[41] 27. (Amended) The method of claim [40] 26, wherein the new write operation further comprises:

allocating a new cache line;

writing data from the write request to the line allocated; and

queuing up a disk write operation, wherein the disk write operation will transfer the new data from the cache to a disk in a later disk memory operation.

[50] 28. (Amended) An apparatus comprising:

a storage device; and

a non-volatile cache memory coupled to the storage device.

[51] 29. (Amended) The apparatus of claim [50] 28 wherein the storage device includes a part capable of moving.

[52] 30. (Amended) The apparatus of claim [51] 29 further comprising:

a controller coupled to the non-volatile cache memory to queue up input-output requests while the part is not moving.

[53] 31. (Amended) The apparatus of claim [51] 29 wherein the controller is adapted to perform the queued up input-output requests while the part is not moving.

[54] 32. (Amended) The apparatus of claim [51] 29 wherein the controller comprises software.

[55] 33. (Amended) The apparatus of claim [54] 32 wherein the apparatus further comprises a general-purpose processor coupled to the non-volatile cache memory, and the software comprises a driver for execution by the general-purpose processor.

[56] 34. (Amended) The apparatus of claim [50] 28 wherein the apparatus comprises a system selected from the group comprising a personal computer, a server, a workstation, a router, a switch, and a network appliance, a handheld computer, an instant messaging device, a pager and a mobile telephone.

[57] 35. (Amended) The apparatus of claim [52] 30 wherein the controller comprises a hardware controller device.

[58] 36. (Amended) The apparatus of claim [50] 28 wherein the storage device comprises a rotating storage device.

[59] 37. (Amended) The apparatus of claim [58] 36 wherein the rotating storage device comprises a hard disk drive.

[60] 38. (Amended) The apparatus of claim [59] 37 wherein the non-volatile cache memory comprises a polymer ferroelectric memory device.

[61] 39. (Amended) The apparatus of claim [59] 37 wherein the non-volatile cache memory comprises a volatile memory and a battery backup.

[70] 40. (Amended) An apparatus comprising:

a rotating storage device;

a non-volatile cache memory coupled to the rotating storage device; and

a controller coupled to the cache memory and including:

means for queue first access requests directed to the rotating storage device;

means for spinning up the rotating storage device in response to second access requests; and

means for completing the queued first access requests after the rotating storage device is spun up.

[71] 41. (Amended) The apparatus of claim [70] 40 wherein the first access requests comprise write requests.

[72] 42. (Amended) The apparatus of claim [71] 41 wherein the second access requests comprise read requests.

[73] 43. (Amended) The apparatus of claim [72] 42 wherein the read requests comprise read requests for which there is a miss by the non-volatile cache memory.

[74] 44. (Amended) The apparatus of claim [71] 41 wherein the first access requests further comprise prefetches.

[75] 45. (Amended) The apparatus of claim [74] 44 wherein the read requests comprise read requests for which there is a miss by the non-volatile cache memory.

[80] 46. (Amended) A method of operating a system which includes a rotating storage device, the method comprising:

spinning down the rotating storage device;

receiving a first access request directed to the storage device;

queuing up the first access request;

receiving a second access request directed to the storage device;

in response to receiving the second access request, spinning up the rotating storage device; and

servicing the second access request.

[81] 47. (Amended) The method of claim [80] 46 further comprising:

servicing the first access request.

[82] 48. (Amended) The method of claim [81] 47 wherein the system further includes a cache coupled to the rotating storage device, and the second access request comprises a read request that misses the cache.

[83] 49. (Amended) The method of claim [81] 47 wherein the servicing of the first access request is performed after the servicing of the second access request.

[84] 50. (Amended) The method of claim [83] 49 wherein the second access request comprises a read request.

[85] 51. (Amended) The method of claim [84] 50 wherein the system further includes a cache, and the queuing up the first access request comprises recording the first access request in the cache.

CLEAN VERSION OF CLAIMS PER 37 CFR § 1.121

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8. A method of processing memory requests, the method comprising:

receiving a request for a memory operation;

determining if data for the memory operation already exists in a cache memory;

performing a cache memory operation, if the data already exists in the cache;

if the data does not already exist in the cache:

accessing a hard disk that contains the data for the memory request;

performing a disk memory operation; and

performing any queued up disk memory operations.

9. The method of claim 8, wherein the memory operation is a read operation.

10. The method of claim 8, wherein accessing a hard disk further comprises spinning up the hard disk.

11. The method of claim 10, the method further comprising spinning down the hard disk after performing any queued up disk memory operations.

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12. The method of claim 8, wherein if the data does not already exist in the cache, the method further comprising:

determining if the request is part of a sequential stream;

if request is part of a sequential stream, deallocating cache lines in the cache memory and prefetching new cache lines;

if request is not part of a sequential stream, determine if prefetch is desirable; and

if prefetch is desirable, prefetch data.

13. The method of claim 12, wherein the prefetch is queued up as a disk memory operation.

14. The method of claim 8, wherein performing any queued up disk memory operations further comprises determining if the queued up disk memory operations are desirable and then performing the queued up disk memory operations that are desirable.

15. The method of claim 8, wherein the memory operation is a write operation.

16. The method of claim 8, wherein the cache operation further comprises writing data into the cache.

17. The method of claim 16, wherein the cache operation further comprises queuing up a disk memory operation, wherein the disk memory operation will transfer the data to the disk.

18. The method of claim 17, wherein the queued up disk memory operations are periodically reviewed to ensure their continued desirability.

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19. The method of claim 8, wherein the disk memory operation further comprises writing data to the disk.

20. The method of claim 8, wherein the queued up memory operations include writing data from the cache to the disk.

21. A method of performing a read memory operation, the method comprising:

receiving a read request;

determining if data to satisfy the read request is located in the cache;

satisfying the read request from data in the cache, if the data is located in the cache;

if the data is not located in the cache, performing a disk read operation, wherein the disk read operation comprises:

accessing the disk;

allocating a new cache line;

transferring data from the disk to the new cache line; and

satisfying the request.

22. The method of claim 21, wherein accessing the disk further comprises spinning up a hard disk.

23. The method of claim 22, wherein the method further comprises spinning down the hard disk after satisfying the request.

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24. The method of claim 21, wherein the disk read operation further comprises:

determining if the data transferred from the disk to the new cache line is part of a sequential stream;

if the data is part of a sequential stream, prefetching new cache lines;

if the data is not part of a sequential stream, determining if prefetch is desirable; and

if prefetching is desirable, performing a prefetch.

25. The method of claim 21, wherein prefetching further comprises queuing up a prefetch operation to be executed during a next disk memory operation.

26. A method of performing a write memory request, the method comprising:

receiving a write request;

determining if at least one line in the cache is associated with the write request;

if at least one line in the cache is associated with the write request, performing a cache write to the line; and

if no lines in the cache are associated with the write request, performing a new write operation.

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27. The method of claim 26, wherein the new write operation further comprises:

allocating a new cache line;

writing data from the write request to the line allocated; and

queuing up a disk write operation, wherein the disk write operation will transfer the new data from the cache to a disk in a later disk memory operation.

28. An apparatus comprising:

a storage device; and

a non-volatile cache memory coupled to the storage device.

29. The apparatus of claim 28 wherein the storage device includes a part capable of moving.

30. The apparatus of claim 29 further comprising:

a controller coupled to the non-volatile cache memory to queue up input-output requests while the part is not moving.

31. The apparatus of claim 29 wherein the controller is adapted to perform the queued up input-output requests while the part is not moving.

32. The apparatus of claim 29 wherein the controller comprises software.

33. The apparatus of claim 32 wherein the apparatus further comprises a general-purpose processor coupled to the non-volatile cache memory, and the software comprises a driver for execution by the general-purpose processor.

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34. The apparatus of claim 28 wherein the apparatus comprises a system selected from the group comprising a personal computer, a server, a workstation, a router, a switch, and a network appliance, a handheld computer, an instant messaging device, a pager and a mobile telephone.

35. The apparatus of claim 30 wherein the controller comprises a hardware controller device.

36. The apparatus of claim 28 wherein the storage device comprises a rotating storage device.

37. The apparatus of claim 36 wherein the rotating storage device comprises a hard disk drive.

38. The apparatus of claim 37 wherein the non-volatile cache memory comprises a polymer ferroelectric memory device.

39. The apparatus of claim 37 wherein the non-volatile cache memory comprises a volatile memory and a battery backup.

40. An apparatus comprising:

a rotating storage device;

a non-volatile cache memory coupled to the rotating storage device; and

a controller coupled to the cache memory and including:

means for queuing first access requests directed to the rotating storage device;

means for spinning up the rotating storage device in response to second access requests; and

means for completing the queued first access requests after the rotating storage device is spun up.

41. The apparatus of claim 40 wherein the first access requests comprise write requests.

42. The apparatus of claim 41 wherein the second access requests comprise read requests.

43. The apparatus of claim 42 wherein the read requests comprise read requests for which there is a miss by the non-volatile cache memory.

44. The apparatus of claim 41 wherein the first access requests further comprise prefetches.

45. The apparatus of claim 44 wherein the read requests comprise read requests for which there is a miss by the non-volatile cache memory.

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46. A method of operating a system which includes a rotating storage device, the method comprising:

spinning down the rotating storage device;

receiving a first access request directed to the storage device;

queuing up the first access request;

receiving a second access request directed to the storage device;

in response to receiving the second access request, spinning up the rotating storage device; and

servicing the second access request.

47. The method of claim 46 further comprising:

servicing the first access request.

48. The method of claim 47 wherein the system further includes a cache coupled to the rotating storage device, and the second access request comprises a read request that misses the cache.

49. The method of claim 47 wherein the servicing of the first access request is performed after the servicing of the second access request.

50. The method of claim 49 wherein the second access request comprises a read request.

51. The method of claim 50 wherein the system further includes a cache, and the queuing up the first access request comprises recording the first access request in the cache.